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भाग 2 वो-पट्टा ड्राइव

(पहला पुनरोक्षण)

Indian Standard

POWER TRANSMISSION — BELTS — CODE OF PRACTICE FOR SELECTION, STORAGE, INSTALLATION AND MAINTENANCE OF BELTING FOR POWER TRANSMISSION

PART 2 V-BELT DRIVES

(First Revision)

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NEW DELHI 110002

December 1991 **Price Group 4**

Pulleys and Belts Sectional Committee, LM 09

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Pulleys and Belts Sectional Committee had been approved by the Light Mechanical Engineering Division Council.

This standard was originally published in 1973.

There are various types of drives used for power transmission in the engineering industry. This code relates to belt drives. The purpose of this code is to unify the diverse practices prevalent for the selection, storage, installation and maintenance of belt drives.

Selection of belt drives for power transmission depends on a number of design factors and service conditions. It is hoped that the information contained in this code in regard to the selection of drives of the choice of belt would be of assistance to the users of belt drives.

Where the provisions of this standard conflict with the statutory requirements the latter shall prevail.

The present first revision of this standard has been brought out in the light of prevalent technical practices followed in the country and following changes have been made:

a) Incorporated lower size limitation of jockey pulley and should not be less than smaller pulley.

b) Incorporated additional factors for selection of V-belts.

c) Maximum belt speed increased.

d) Specific values of forces have been replaced by range of forces to assess satisfactory condition of belt tension.

A list of relevant standards pertaining to allied items is given in Annex A.

Indian Standard

POWER TRANSMISSION — BELTS — CODE OF PRACTICE FOR SELECTION, STORAGE, INSTALLATION AND MAINTENANCE OF BELTING FOR POWER TRANSMISSION

PART 2 V-BELT DRIVES

(First Revision)

1 SCOPE

This Indian Standard (Part 2) provides guidance for selection, storage, installation and maintenance of V-belt drives for power transmission.

2 REFERENCE

The Indian Standard IS 2494 : 1974 'V-belt for industrial purposes (*first revision*)'is necessary adjunct to this standard.

3 SELECTION OF V-DRIVE

3.1 Selection of a belt drive is normally based on factors like the space available, power to be transmitted, speed of the driver and the driven shafts, the service conditions and number of working hours.

3.2 Reference may be made in this connection to IS 2494 : 1974 wherein full details are given on the subject of correct selection of V-drives for industrial purposes.

3.3 When selecting the belt for a drive, it is always desirable to make use of the recommendations of the manufacturer.

4 DRIVE-LAYOUT

4.1 In case of V-belts drive, the maximum ratio between the pulley diameters should not be more than 7:1.

4.2 V-Drive

4.2.1 *Plain Drive*

There is an almost infinite range of variations possible in drive layout. The simplest drive is where the centres are horizontal as shown in Fig. 1. This drive could be laid out with the slack side either at the top or below the centres. In V-belt drive this has little effect on the overall efficiency of the drive.

4.2.1.1 *Vertical drive*

Generally vertical drives are not recommended because V-belts will have a tendency to sag under their weight and come off the groove. However, taking special care with regard to tensioning, this difficulty can be minimized and special drives can be designed.

4.2.2 *Quarter-Turn Drive*

This is a drive in which both the shafts lie in parallel planes but the shafts themselves are not parallel (*see* Fig. 2). Special deep grooved pulleys need to be used to ensure that the belts transmit the required power and the centre distances have to be extended more than usual for the V-drives to ensure that the belts do not twist excessively. The direction of rotation must be such that the bottom layer of belts is in tension.

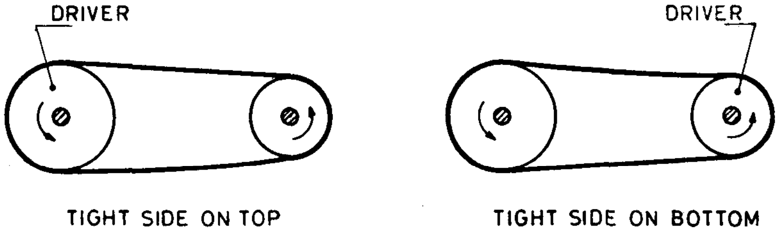


FIG. 1 HORIZONTAL DRIVE

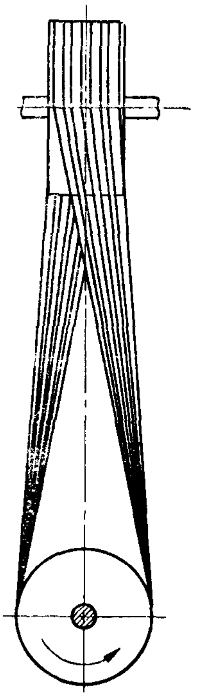


FIG. 2 QUARTER-TURN DRIVE

4.2.3 *Jockey-Pulley Drive*

Where adjustment of centre distance cannot possibly be arranged, it is necessary to use a Jockey pulley tensioning device (*see* Fig. 3). A grooved tensioning pulley may be used, and this should be placed on the inside of the V-belts, mounted as near as possible to the larger pulley, and preferably on the slack side of the drive. Alternatively, a flat faced jockey pulley may be used on the outside of the belts (preferably on the slack side of the drive) and should be positioned within one-third of the centre distance from the driving pulley. Jockey pulley diameters should be at least equal to that of the smaller pulley of the drive, but larger if possible.

4.3 V-Flat Drives

On some drives with a speed ratio of 3 to 1 or more, and where the centre distance is not greater than the difference in pulley diameters it is possible to utilize a large flat faced pulley as the driven pulley. The friction grip provided by the base of the V-belts on the large flat pulley will not be less than the wedge-grip in the smaller, grooved pulley. This drive, however, would not be suitable where excessive loads or shock conditions are obtained.

5 DESIGN OF V-BELTS DRIVES

5.1 Pulleys

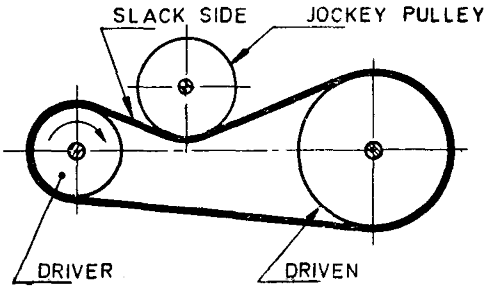
The satisfactory working of a V-drive is related to the economic usage of the power capabilities of the belts used. Care should therefore be taken to ensure that V-pulley diameters are above the minimum recommended by the manufacturer of V-belts and that the grooves conform to the design requirements of the V-belts used. Where a large flat pulley is used on a V-flat drive the pulley must be flat, not crowned.

5.2 V-Belts

The internal friction caused by flexing a V-belt over a small pulley reduces the life of the belt. Care should therefore be taken to see that the correct type of belt is selected to transmit the required power using an appropriate section selection from the manufacturers catalogue which utilize pulley diameters above minimum recommended, bearing in mind that the higher the belt speed the greater the power the same belt can transmit. Maximum belt speeds should not exceed 30 m/s without consulation with the manufacturer. Annex B and C give a guidance regarding correct selection of V-belts.

5.3 Pulley Centres

Belt life may be measured in terms of the number of times the belt surface comes into



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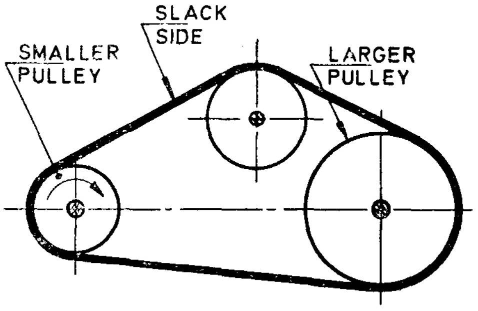


3B

FIG. 3 JOCKEY-PULLEY DRIVE

contact with the pulley surface while transmitting the load. Trip rate, being the number of passes of the belt round the drive in one second, should not be more than 12 but it must be remembered that centre distances are, in general, shorter than conventional flat belt drives and are normally between 'D' and '$3D$' where the 'D' is the diameter of the larger pulley. Should it be required to find the centre distance when only the belt length is known, the following formula may be used:

$$\text{Centre distance} = C = A + \sqrt{A^2 - B}$$

where

$$A = L/4 - 0{\cdot}392\,5\ (D + d)$$

$$B = \frac{(D - d)^2}{8}$$

L = Pitch length of belt,

D = Pitch diameter of larger pulley, and

d = Pitch diameter of smaller pulley.

5.3.1 In the case of quarter twist drives the centres must be extended to ensure that the belts are not unduly stressed as a result of the twisting and should not be below 5·5 ($P+Q$), where P is the larger pulley pitch diameter and Q is the witdh of the band of belts.

5.3.2 Provisions should also be made for the adjustment of the centre distance to take up slack that will accrue when the belts are put into service. The normal manner is to provide slide rails on the motor. Sufficient movement should be provided to enable a minimum change over the nominal centre distances on the basis of 3 percent stretch.

6 INSTALLATION OF V-BELT DRIVES

6.1 In assembling a drive, the motor or prime mover should be moved towards the driven unit so that the V-belts may be placed in their respective grooves by hand.

6.1.1 Under no circumstances should V-belt be forced on to pulleys with crowbars, wedges, screw drivers, or any other type of implement. Such procedure would tend to cause the outside jacket or inside cords, or, both, to rupture. It is possible for the inside load-carrying cords to be broken by forcing over the grooves, without this being evident from the outside appearance of the V-belt. Such V-belts fail completely during the first few hours of running.

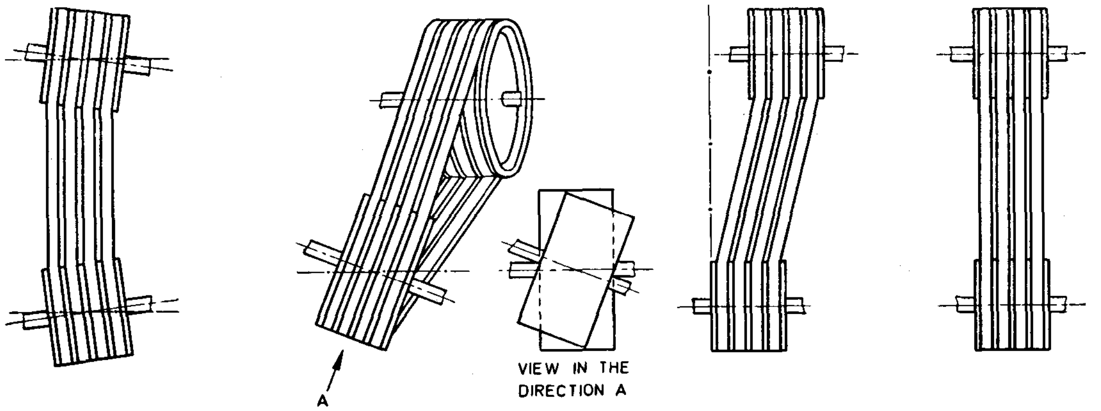
6.1.2 When the V-belts have been placed in the pulley grooves, the motor or prime mover should then be moved away from the driven unit to apply uniform tension to the V-belts.

6.2 It is important to maintain an even spread of the power load over the belts matched for length against that of the other belts in a drive. Accordingly manufacturers code each belt for length after production and care should be taken to select a suitable matched set of belts to avoid uneven distribution of load.

6.3 Alignment

Figure 4 shows the various positions of alignment. The alignment of the pulley should be so that flat sides of the pulleys are in accordance with Fig. 4D.

Details shown in Fig. 4 can be ensured by placing a string or flat board across the faces of the two pulleys.



4A SHAFTS ARE NOT PARALLEL TO ONE ANOTHER

4B SHAFTS ARE NOT IN CORRECT ALIGNMENT, ALTHOUGH THEY APPEAR PARALLEL WHEN SEEN FROM ABOVE

4C SHAFTS ARE PARALLEL AND IN ALIGNMENT, BUT PULLEYS ARE NOT IN ALIGNMENT

4D CORRECT INSTALLATION, BOTH SHAFTS AND PULLEYS ARE PARALLEL AND IN ALIGNMENT

FIG. 4 ALIGNMENT OF V-DRIVE

6.3.1 In the case of quarter twist drives details are as follows:

The axis of the vertical shaft should lie in a plane perpendicular to the horizontal shaft and intersecting it at the centre of the face of the pulley of the vertical shaft which should be below the axis of the horizontal shaft by a specified distance '*Y*' (*see* Fig. 5) which depends on the centre distance as shown below:

Centre Distance	*Distance Y*
mm	mm
1 500	63
2 000	71
2 500	80
3 000	100
3 500	125
4 000	160
4 500	200
5 000	224
5 500	250
6 000	300
6 500	355
7 000	400
7 500	450

6.4 Belts, after correctly tensioning, are liable to stretch up to 3 percent of their length and where a take-up adjustment is to be provided, it should be sufficient to take up the whole of this amount.

6.4.1 Excessive tension leads to rapid wearing out of the belt and overloading of the bearings. Insufficient tension on the other hand is the chief cause of belts failing to transmit power owing to slip.

6.5 Belt dressings shall not be applied to V-belt drives.

6.6 Recommended practice for installation tension in V-belt drives is given in Annex **B**.

7 SAFETY

The belt drives should be suitably guarded or fenced in accordance with safety requirements of the Indian Factories Act. Where guards are necessary it is desirable to use the wire screen type rather than air-tight covers so as to permit free circulation of air and dissipation of any heat generated.

8 STORAGE OF V-BELT DRIVES

V-belts should be stored in a cool, dry, closed room. They may be hung or coiled flat in single or triple coils so that the belt retains its natural shape and does not twist upon itself. If the belts are hung, then the minimum diameter of the peg should be ten times the belt height.

9 MAINTENANCE OF V-BELT DRIVES

9.1 Inspection of V-Drives

It is important to check on the correct running of the drive from time to time to ensure correct tension and true running of the installation.

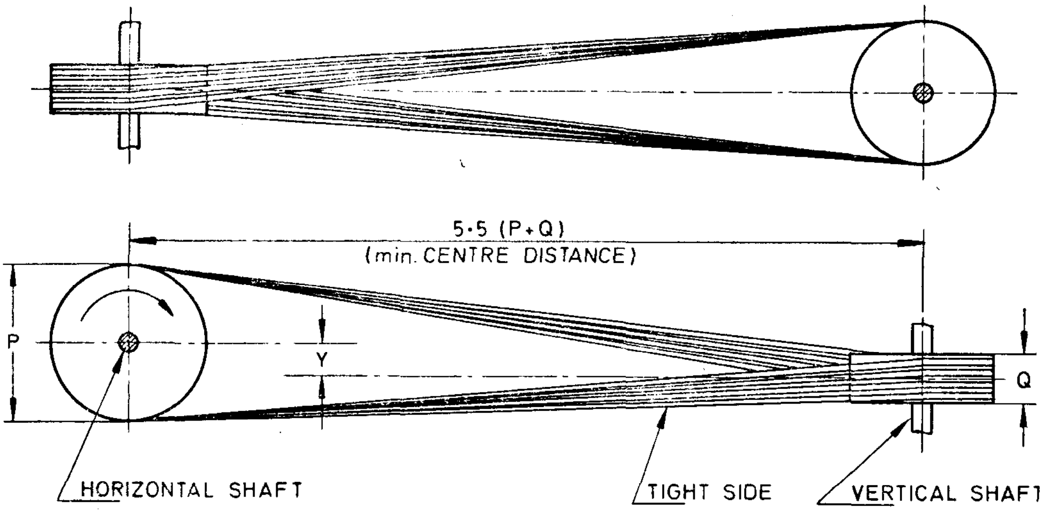


FIG. 5 QUARTER-TWIST ALIGNMENT DRIVE

9.2 Faults in V-Belt Drives and their Correction

9.2.1 *Abrasion*

Metal particles, sawdust and grit are the usual causes of abrasion. Stop entry of these foreign materials by covering the top and/or one side of the drive. But where guards are necessary, it is desirable to use the wire screen type rather than air-tight covers, so as to permit free circulation of air.

9.2.2 *Excessive Stretch*

This is usually due to overloading or internal breaks which are easily caused, but not noticed if V-belts are forced over tops of grooves. Check if extra duty may have been added subsequently to the drive design and installation.

9.2.3 *Loss in Driven Speed*

This is often due to slippage resulting from insufficient tension. Check by tachometer readings against calculated speeds and remedy by adjusting tension. Slippage will result from the use of belt dressing which should never be employed on V-belts. Any application is bound to be unevenly spread with the result that one or more V-belts will tend to carry the full load.

9.2.4 *V-Belt Swelling or Softening*

This is caused by oil, certain cutting fluids or rubber solvent. Remove cause, if possible, or use special oil resistant belts.

9.2.5 *Mixing of V-Belts*

V-Belts of different brands or types must not be mixed; the slightest difference in cross section and internal design will seriously affect running life. New and used V-belts should not be run together in the same set for similar reasons. When making replacements, always fit all new or all used V-belts in the same set.

9.2.6 *Inability to Transmit Rated Load*

This may be the result of the pulley grooves being cut unevenly, or of incorrect angle. Check each single groove with a template to ensure all V-belts are running on the same pitch diameter. Have the drive design checked over to see that the drive has sufficient capacity for the load.

9.2.7 *Whipping During Running*

This is usually caused by incorrect tensioning principally on long centre drives. Try a slightly higher (or lower).

9.2.8 Causes and remedies of V-belt problems are tabulated in Annex D for guideline.

ANNEX A

(*Foreword*)

LIST OF INDIAN STANDARDS PERTAINING TO ALLIED ITEMS

IS No.	*Title*
2048 : 1983	Parallel keys and keyways (*second revision*)
2291 : 1981	Tangential keys and keyways (*second revision*)
2293 : 1974	Gib-head keys and keyways (*first revision*)
2294 : 1986	Woodruff keys and keyways (*second revision*)
2398 : 1967	Identification code for rolling bearings
2399 : 1988	Roller bearings — Vocabulary (*first revision*)
2494 : 1974	V-belts for industrial purposes (*first revision*)
3090 : 1965	Code of practice for installation and maintenance of rolling bearings
3142 : 1982	V-grooved pulleys for V-belts—groove sections A, B, C, D and E
3688 : 1977	Dimensions for shaft ends (*first revision*)
5669 : 1987	General plan of boundary dimensions for radial rolling bearings (*first revision*)
5692 : 1988	Tolerances for rolling bearings (*first revision*)
6453 : 1984	Technical supply conditions for rolling bearings (*first revision*)

ANNEX B

(*Clauses* 5.2 *and* 6.6)

RECOMMENDED PRACTICE FOR INSTALLATION TENSION IN V-BELT DRIVES

B-1 V-belts work satisfactorily over a wide range of belt tensions so that rough and ready methods of deciding on belt tension have not resulted in serious troubles wiih the drive. There are cases when it is desirable to be able to measure tensions, to avoid bearing trouble, belt slip or to meet particularly arduous conditions. The following procedure is sufficiently accurate for drives coming within the normal range for each belt section.

B-2 Measure the length of the span in millimetres.

At the centre of the span apply force *P* with a spring scale in direction perpendicular to the span, until the belt is deflected from the normal by an amount equal to 0·016 mm for every millimetre of span length (*see* Fig. 6).

In the case of a single belt drive, both pulleys shall be locked before making the measurement. For example, the deflection for a span of 100 mm would be 1·6 mm. Note the force *P* and compare it with Table 1.

B-3 The belt tension should be such that the measured force falls within the values given in Table 1. A measured force below the lower value indicates undertensioning, whilst a measured force above the higher value indicates overtensioning. However, when starting up a drive with new belts the drive should be tensioned to the higher value since the tension falls rapidly in the early stages of running in.

All belt drives should be watched carefully during the running in period after initial start-up. Retensioning should be carried out by the above procedure when necessary.

Table 1 Deflection Force Required for Measuring Installation Tension in V-Belt Drives

(*Clauses* B-2 *and* B-3)

V-Belt Section	Forced Required to Deflect V-Belt 16 mm per metre of Centre Distance Newton (N)
A	10 to 15
B	20 to 30
C	40 to 60
D	70 to 105
E	120 to 180

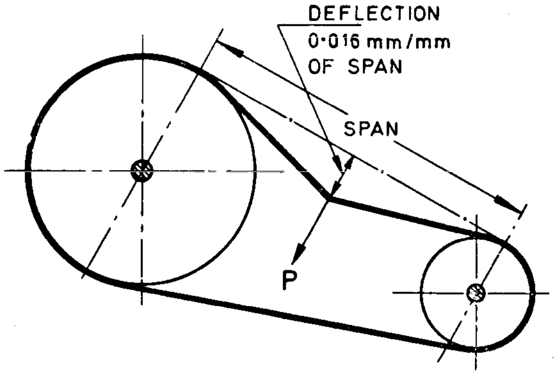


FIG. 6 BELT DEFLECTION MEASUREMENT

ANNEX C

(*Clause* 5.2)

CALCULATION OF LOAD IMPOSED BY V-BELT DRIVE ON SHAFTS

C-1 FORCE DETERMINATION

C-1.1 To determine the force imposed on a shaft by V-belt drive in order to calculate bearing load, take the vector sum of three forces:

a) Tight-side tension in drive (T_1),

b) Slack-side tension in drive (T_2), and

c) Weight of pulley.

$$T_1 = \frac{2\cdot5}{2Fd} \times \frac{1\,000 \times \mathrm{kW}}{S} \text{ in Newton (N)}$$

$$T_2 = \frac{2\cdot5 - 2Fd}{2Fd} \times \frac{1\,000 \times \mathrm{kW}}{S} \text{ in Newton (N)}$$

W = weight of pulley in Newton (N)

where

S = belt speed in metres per second

Fd = the arc of contact correction factor (*see* IS 2494 : 1974)

kW = the motor or absorbed power of the machine

NOTE — 1 Newton (N) $\simeq$ 0·102 × kilogram force (kgf).

C-2 RESULTANT FORCE

C-2.1 This may be solved graphically or analytically by resolving the following two forces:

a) Load due to belt pull ($T_1 + T_2$) and

b) Weight of pulley (W).

or Resultant Force (R) = $(T_1+T_2)^2+W^2$ assuming the two forces are at right angle to each other.

ANNEX D

(*Clause* 9.2.8)

CAUSES AND REMEDIES OF V-BELT PROBLEMS

Problems	*Causes*	*Remedies*
Belt breaking after fitting	Forcing belt over pulley when fitting, damaging cord and cover	Reduce drive centre distance to fit belt
	Ingress of a foreign body, during running	Fit an effective guard
	Insufficient belts, or wrong section for drive	Check drive details and fit correct number or section of belts
	Drive stalled	Ascertain cause and set right
Cuts and splits in the base of the belt	Outside idler pulley in use	Replace with inside idler pulley on the slack side of the drive. Increase the size of the existing idler
	Pulley diameter too small	Redesign using recommended minimum pulley pitch diameters
	Ambient temperature too high (above + 70°C)	Ensure good ventilation and protect the belts from direct heat
	Abnormal belt slip	Check drive design to ensure correct number of belts. Redesign if necessary. Check drive tension;

Problems	*Causes*	*Remedies*
Severe belt vibration	Drive has insufficient belts	Check drive design and modify necessary
	Centre distance longer than recommended	Shorten centres. Use an inside idler in the drive on slack side
	High shock loading	Use an inside idler pulley in the slack side
	Too low belt tension	Correct it
	Unbalanced pulleys	Balance pulleys
Belts turn over in pulleys	Poor drive alignment	Realign
	Incorrect pulley groove section or excessive wear in grooves	Renew pulleys
	Excessive belt flat	Use an inside idler in the drive on slack side
	Low belt tension	Retension
	Worn out belts	Renew belts
	Ingress of a foreign body	Use a more effective drive guard
Belts cannot be retensioned	Insufficient allowance for stretch in drive design	Modify drive to allow more take-up
	Excessive stretch caused by insufficient belts or wrong belt section for drive	Recalculate drive design and modify
	Incorrect belt length	Use a shorter belt
	Belts from different manufacturers used on same drive	For use as a matched set, belts must be from one manufacturer
Excessive wear on	Incorrect pulley groove angle Incorrect pulley section	Renew or remachine pulleys Renew pulleys
	Excessive wear in pulley grooves	Renew or remachine pulleys
	Poor drive alignment	Realign
	Small pulley diameter below recommended minimum	Redesign using correct pulley diameters
	Belt catching on protruding parts	Remove protrusions or move drive away
Excessive noise	Poor drive alignment	Realign
	Incorrect belt tension	Retension
	Overloaded drive	Check drive details and redesign if necessary
	Unbalanced pulleys	Balance pulleys
Belt swelling or softening	Contamination by oil or other chemicals	Protect drive from contamination. Clean pulley grooves with petrol or alcohol before fitting new belts
Unusual belt stretch	Worn or badly machined pulley grooves	Remachine or renew pulleys
	Used belts mixed with new belts on the drive	Replace with a complete new set of belts
	Belts from different manufacturers used on same drive	Use V-belts of one make only

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